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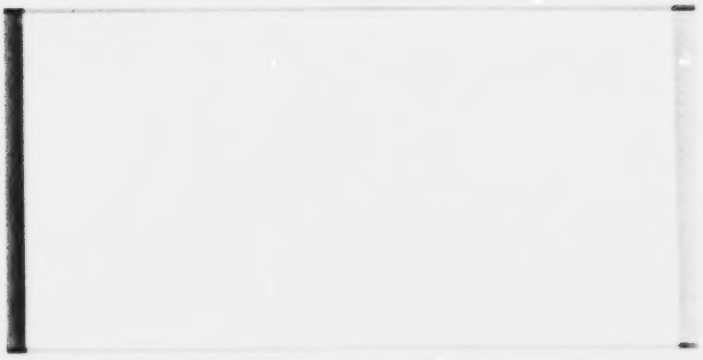

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REMOTE MONITORING OF OPGS VALVE CHAMBER EXTENSOMETERS

Report No 86-168-K

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ABSTRACT

A remote monitoring system was installed at OPGS to monitor movement of the rock slope above the powerhouse roof. Extensometer readings can be retrieved from the site at any time over telephone lines with the aid of a computer. This enables the engineer to be in constant touch with the project so that remedial actions can be undertaken at an early stage if and when necessary.

job	file	date	report no.
740644-153-501	844.33	June 19, 1986	86-168-K

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REMOTE MONITORING OF OPGS VALVE CHAMBER EXTENSOMETERS

1.0 INTRODUCTION

A remote monitoring system has been installed by the Rock Sciences Section (Civil Research Department) at the Ontario Power Generating Station (OPGS) in Niagara Falls to monitor movement of the rock slope above the powerhouse roof. The purpose of this installation is to enable the engineer to be in continuous contact with the project so that remedial measures can be instigated at an early stage if and when necessary. The stored data at the OPGS site can be retrieved at any time over telephone lines from the office to permit rapid viewing and plotting of results.

Prior to the installation of this system, the three extensometers in the valve chamber (OP-2, OP-3 and OP-4) were read manually using a micrometer. Typical problems inherent with the original setup include: 1) errors in reading due to improper procedures or lack of understanding, 2) forgetting to take readings, 3) infrequent readings due to other priorities, 4) delays in reporting results, and 5) delays in analyzing data.

This report discusses the installation of the remote monitoring system as well as the computer programming required in setting up the transmission of data from the site to the office (ie Civil Works Department).

2.0 REMOTE MONITORING SYSTEM

The extensometer monitoring system (Figure 1) consists of the following major components: 1) rebuilt extensometer heads to enable placement of linear variance displacement transformers (LVDT's) 2) power supply and LVDT's for each extensometer point, 3) transmission cables from LVDT's to data logger, 4) data logger on site, 5) cassette player, 6) modems and telephone lines, and 7) office computer with printer and/or plotter.

2.1 Rebuilt Extensometer Heads

The reference plates, which contain the holes through which the

readings were taken with a micrometer, were removed from the remainder of the extensometer heads (Figure 2). These plates were originally held in place with set screws to ensure that no movement could take place. Prior to the removal of the plates, manual readings were taken with a micrometer.

Upon removal, (Figure 3) the reference plates were modified (Figure 4) to enable placement of linear variance displacement transformers (LVDT's). Each LVDT (see next section) was fixed to a brass rod which was in turn threaded to the reference plate and tightened with a nut (Figure 5). The rod was designed to rotate in an elliptical pattern to enable better centering of the LVDT onto the extensometer rod. A hole was drilled and tapped in the centre of each extensometer rod to allow threading of the moveable LVDT core. At this stage the head containing the LVDT's was refastened to the remainder of the exposed head and secured with the set screws. The LVDT's were centered and tightened over the tops of the extensometer rods containing the threaded LVDT cores. Subsequent to this, a custom-built protection PVC sleeve was threaded on to surround the LVDT's (Figure 6 and 7). A cap, which allows the LVDT cables to exit, was then placed overtop of the protective sleeve to fully encapsulate the electronic equipment.

2.2 Linear Variance Differential Transformers(LVDT's)

The LVDT is an electomechanical device that produces an electrical output proportional to the displacement of a separate moveable core. It consists of a primary coil and two secondary coils symmetrically spaced on a cylindrical form. A free-moving rod-shaped magnetic core inside the coil assembly provides a path for the magnetic flux linking the coils. When the core is moved from its null position, the induced voltage in the coil toward which the core is moved increases, while the induced voltage in the opposite coil decreases. This action produces a differential voltage output that varies linearly with changes in core position.

Three LVDT's were installed in each of OP-2 and OP-3 while four were installed in OP-4. All LVDT's (Schaevitz model number 500 HPD) are DC-operated with a nominal linear range of +12.5mm. In these units, tungsten inert gas and electron beam welding provide hermetic sealing that is free from oxidation-producing faults that may cause leakage. For this reason, these LVDT's are impervious to dirt, water, steam, spray and most corrosives. They also have double magnetic shielding that makes them insensitive to external magnetic influences. The LVDT's are powered with a hermetically sealed power supply capable of generating 15 volts DC and a minimum current of 500 milliamps.

2.3 Transmission Cable

The transmission cable is composed of 22 gauge, 4 to 30 ma standard twisted pair with shielding and covered with a durable waterproofed polyurethane sheathing. Its function is to provide DC voltage to the LVDT's from the power supply and transmit readings from the LVDT's to the data logger. All transmission cables have been placed inside of conduits which have been fastened to the wall of the valve chamber. The power supply and data logger are located on the south end of the valve chamber near extensometer OP-4. The data logger, power supply, tape backup and modem have all been placed inside a Hammond Nema-4 environmental box, which is fixed to the valve chamber wall.

2.4 Data Logger

The Campbell Scientific CR7 data logger is the heart of the system and is responsible for collecting, saving and transmitting data in response to the control program which is entered by the user. The CR7 design represents a modular approach, combining precision measurement (16 bit) with processing and control capability into a single battery operated system. The Control Module includes a 16 pad keyboard and 8 digit LCD display. The user enters programs via this keyboard or downloaded from a computer, which instruct the Control Module to initiate measurements or control functions, process data acquired from the I/O Module and store data in Final Storage.

2.5 Cassette Player

A cassette recorder with a write only interface has been connected to the data logger on site. The data, which is saved in final storage on the logger, is also sent to the recorder as backup.

2.6 Modems and Telephone Lines

Modems (Hayes Smartmodem 1200) allow the data logger on site to communicate via telephone lines to a computer in a remote location. An originate modem on site converts asynchronous data from the RS-232C port of the data logger into synchronous data for transmission over the telephone lines. An answer modem at the remote location (ie Head Office) converts the synchronous data into asynchronous data prior to sending the information into the RS-232C port of the computer for storage. The data transmission rate is 300 bits per second. To enable proper data collection and hangup, the answer modem should have its configuration switches set as follows (from left(1) to right(8)): (1) Up, (2) Down, (3) Down, (4) Up, (5) Up, (6) Up, (7) Up, and (8) Down.

2.7 Computer and Peripherals

An IBM compatible computer with a RS-232C port, 640K memory and preferably a hard disk storage is required to collect data and convert it into engineering units. The computer should have a printer and/or plotter to print and plot data. The program has been set up to run on Lotus 1,2,3 even though other programs, which recognize .prn files, could be used for data manipulation. The original version of Lotus 1,2,3 does not support most colour printers such as the Epson JX-80. It does, however, support most black and white printers. Symphony can be used to make colour plots on the printer, but output is extremely slow. Both Lotus 1,2,3 and Symphony support the HP six pen plotter and thereby provide a faster, better quality plot. Details concerning computer programming for data collection, saving, manipulation, printing and plotting are provided in a subsequent section.

3.0 PROGRAMMING

3.1 Data Logger

The data logger has been programmed to collect readings from all LVDT's every 15 minutes and stores them in intermediate storage for further processing. At the end of a 24 hour period, beginning and ending at midnight, all readings taken at 15 minute intervals during the day are averaged to provide one daily reading. The daily readings are then sent to Final Storage, where they can be accessed for examination. In conjunction with the 10 extensometer point readings, the Julian date, year, program type, offsets and temperature of the CR7 data logger are recorded. The identification, location and depth of each extensometer point is provided in Table 1. The Julian day calendar represents a year of 365 consecutive days in a normal year and 366 consecutive days in a leap year. This calendar is easier to use in data logger applications because months with varying numbers of days can be ignored. Table 2 provides the equivalent Julian date with a twelve month calendar. Program type and offsets is information only useful to the programmer and will not be dealt with any further. As a precaution, a thermocouple was placed inside the Nema-4 environmental box containing the data logger, power supply, modem and cassette player to monitor the temperature inside. A light bulb has been placed inside of the box to dry up any moisture should such moisture enter the box.

3.2 Data Retrieval Program

Subsequent to installing the data retrieval program into an IBM-compatible computer, data can be collected from the OPGS extensometers simply by typing in the batch file command: "OPGS". The batch file performs the following instructions:

a) changes to directory containing telecommunications program
b) calls up OPGS data logger
c) collects data from data logger and opens a .dat file
d) changes to directory containing split program (if necessary)
e) split program sorts data into table format with headings and takes difference in readings from initial point and creates .prn files for OP2, OP3 and OP4
f) creates a report (.rpt) file for printout at a later time
g) changes directories and loads Lotus to enable graphing of data

In order to print out the data in the report files at a later time use the DOS "print" command. Report files can be printed individually or one after the other by placing them in a queue. To obtain an individual file, type the following: print OP2.rpt (or OP3.rpt or OP4.rpt). To print out all three report files, type: print *.rpt. Examples of the printouts obtained in this manner are shown in Appendix A. It should be noted that the printout for OP4 has not numbered the pages properly. This is due to the fact that the Campbell Scientific software does not compensate for extra columns (ie Temperature). Although there is nothing wrong with the output data, it does not make a good report quality printout. An alternative approach would be to print out the data using Lotus 1,2,3 or Symphony.

If one wishes to print out the data at the same time as it is being collected, type the batch file command: "opgsp". This batch file performs all of the same functions as the "opgs" batch file, including an instantaneous printout of data. It should be pointed out, however, that printouts will be the same as those shown in Appendix A.

The program used to set up the parameters for sorting out data from the .dat file is called "SPLIT". Examples of parameter files set up for extensometers OP-2, OP-3 and OP-4 are shown in Appendix B. Split instructions have also been included in the same appendix to enable changes in the parameter files. It is suggested that the user should be very familiar with these instructions prior to making permanent changes. It is extremely important that the .dat files which contain the raw data, are not tampered with in any way.

3.3 Lotus Data Plots

As indicated previously, the batch file command creates a .prn data file which programs such as Lotus and Symphony can understand. To enable the new user to create a plot on screen and on paper, Lotus commands have been included in Table 3. These instructions are valid only if the data has been collected as described previously. Many variations exist with respect to plotting data on the screen or on paper. It is not the intention of this report to deal with Lotus/Symphony capabilities in any

detail. It is recommended that the user become familiar with these programs to enable setting up of plots to his/her own personal preference.

4.0 SYSTEM PERFORMANCE

At the time of writing, the monitoring system has been operational for about four months. All LVDT's appear to be performing well, based on normal temperature cycling of the extensometers. The pattern trend is very similar to that obtained during previous data plots (Azis, 1984). Examples from OP-2, OP-3 and OP-4 are shown in Figures 8, 9 and 10.

5.0 RECOMMENDATIONS

In order to maintain a highly functional and useful monitoring system, the following recommendations should be observed:

1) Data should be collected and viewed regularly so that the behaviour of the rock slope is known. With the aid of the installed computer program, this function can be performed in a matter of minutes.

2) Questionable performance or movement should be reported as soon as possible to the Rock Sciences Section (Civil Research) so that equipment checks can be performed.

3) The monitoring system in the valve chamber should be checked at least once a year to ensure that the equipment is properly calibrated and maintained (ie buildup of calcium deposits, etc).

4) Any alterations required in the computer program, which collects and analyzes the data from the site (not plotting and printing programs, ie Lotus, Symphony), should only be undertaken after consultation with the Rock Sciences Section (Civil Research). This is necessary to enable efficient trouble-shooting if required at some time in the future.

6.0 CONCLUSION

The Rock Sciences Section (Civil Research) has installed a remote monitoring system in the valve chamber of OPGS to monitor the movement of the rock slope above the powerhouse roof. All data can be retrieved from the site, and viewed on a remote computer (ie Civil Works Department) in a matter of minutes. This permits the engineer to be in constant touch with the project so that remedial measures can be instigated at an early stage if and when required.

7.0 ACKNOWLEDGEMENTS

The authors wish to thank the staff at OPGS for their co-

operation, support and assistance in helping to install the remote monitoring system. Mr. J.B. Williams is also acknowledged for his assistance in this program.

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REFERENCES

Azis, I. Ontario Power GS - Review of Instrumentation Monitoring Data - Future Monitoring Requirements, Ontario Hydro Report No 3421H29, August, 1984.

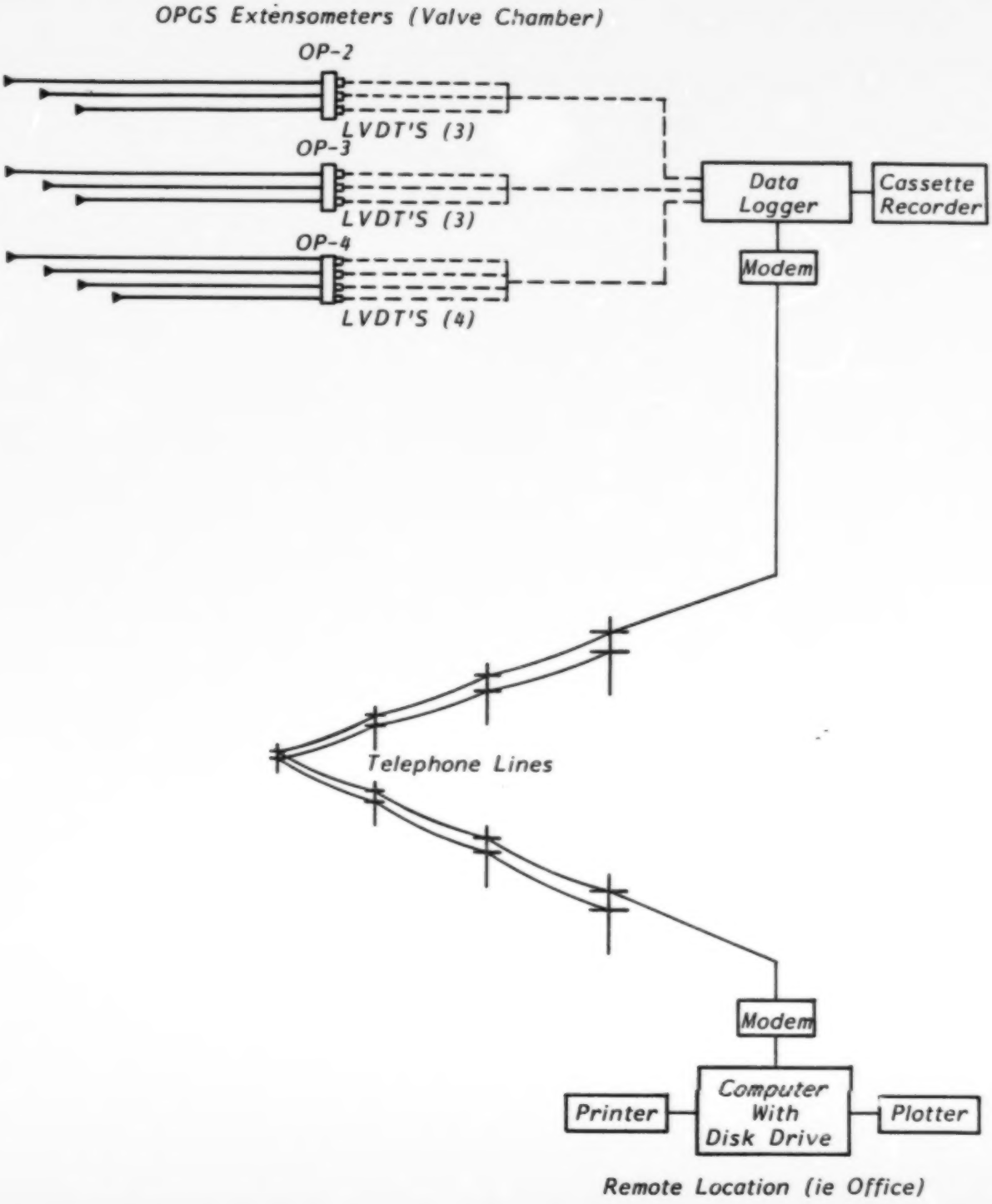

FIGURE 1

REMOTE MONITORING OF OPGS VALVE CHAMBER EXTENSOMETERS

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FIGURE 2 - OP-4 Extensometer Head Prior to Rebuilding

FIGURE 3 - OP-4 Extensometer Head with Cover Removed to Show Extensometer Rods with Thermocouple Cables

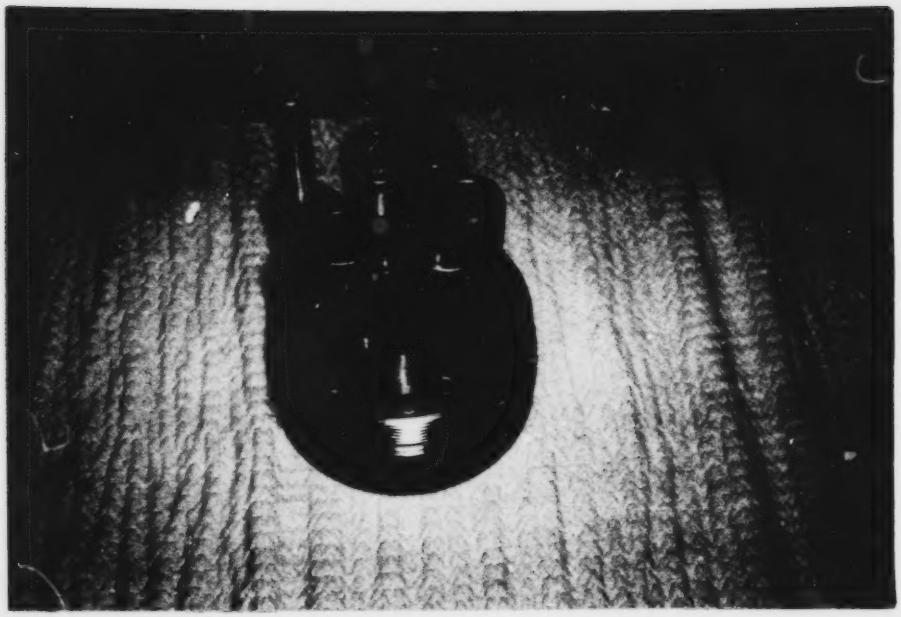


FIGURE 4 - Rebuilt Extensometer Head Showing LVDT Supports

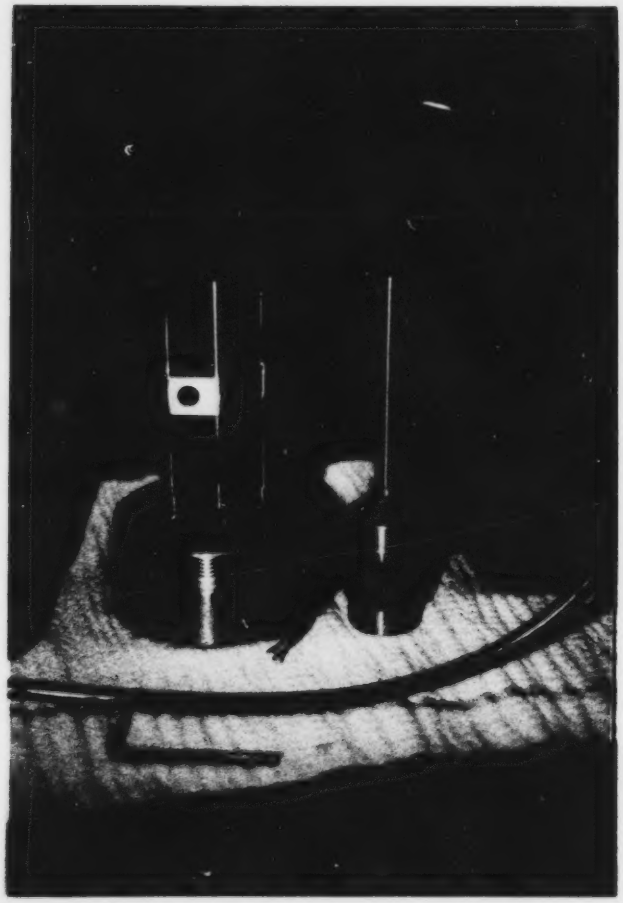


FIGURE 5 - Rebuilt Extensometer Head Showing Brass Support Holding LVDT in Place

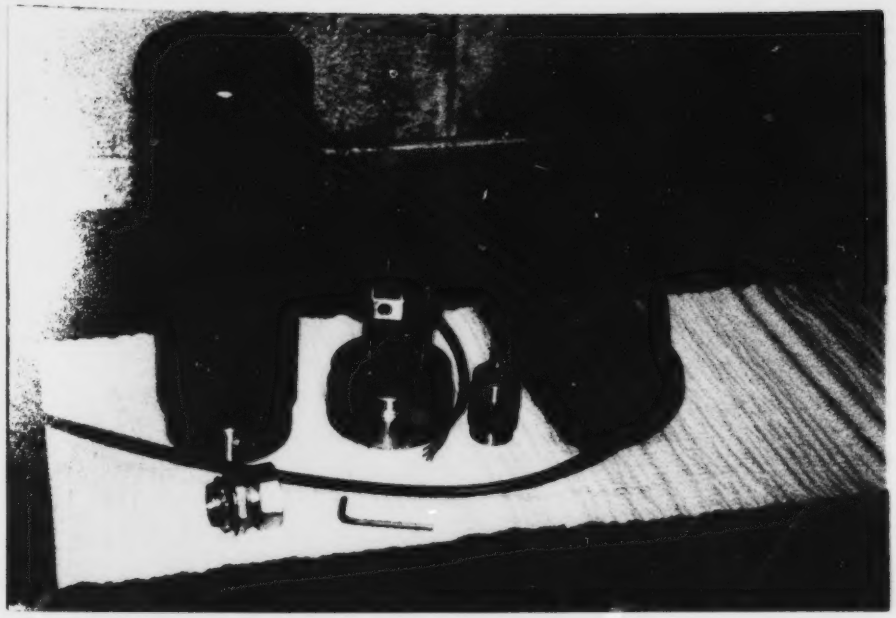


FIGURE 6 - Rebuilt Extensometer Head with Protective PVC Sleeve and End Cap

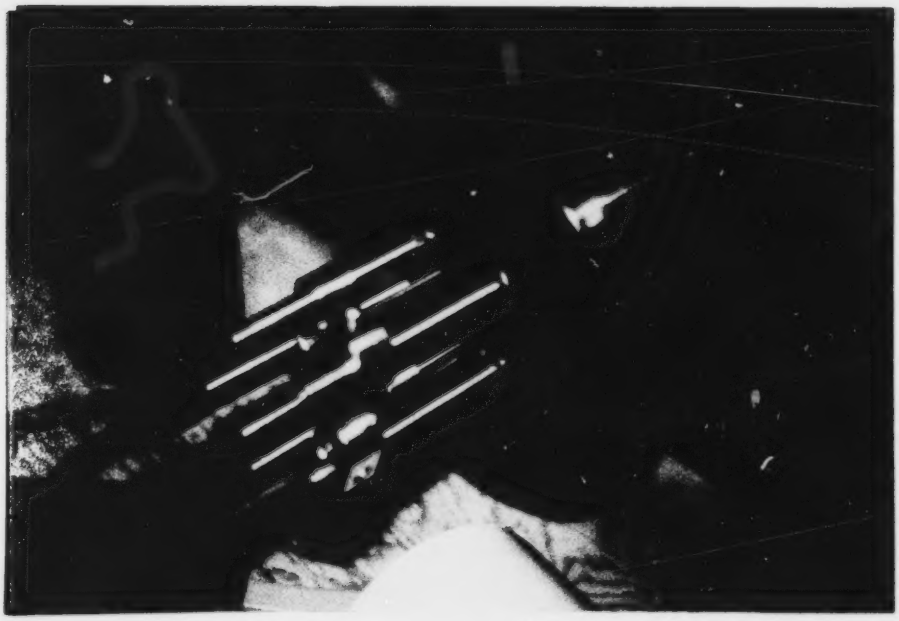
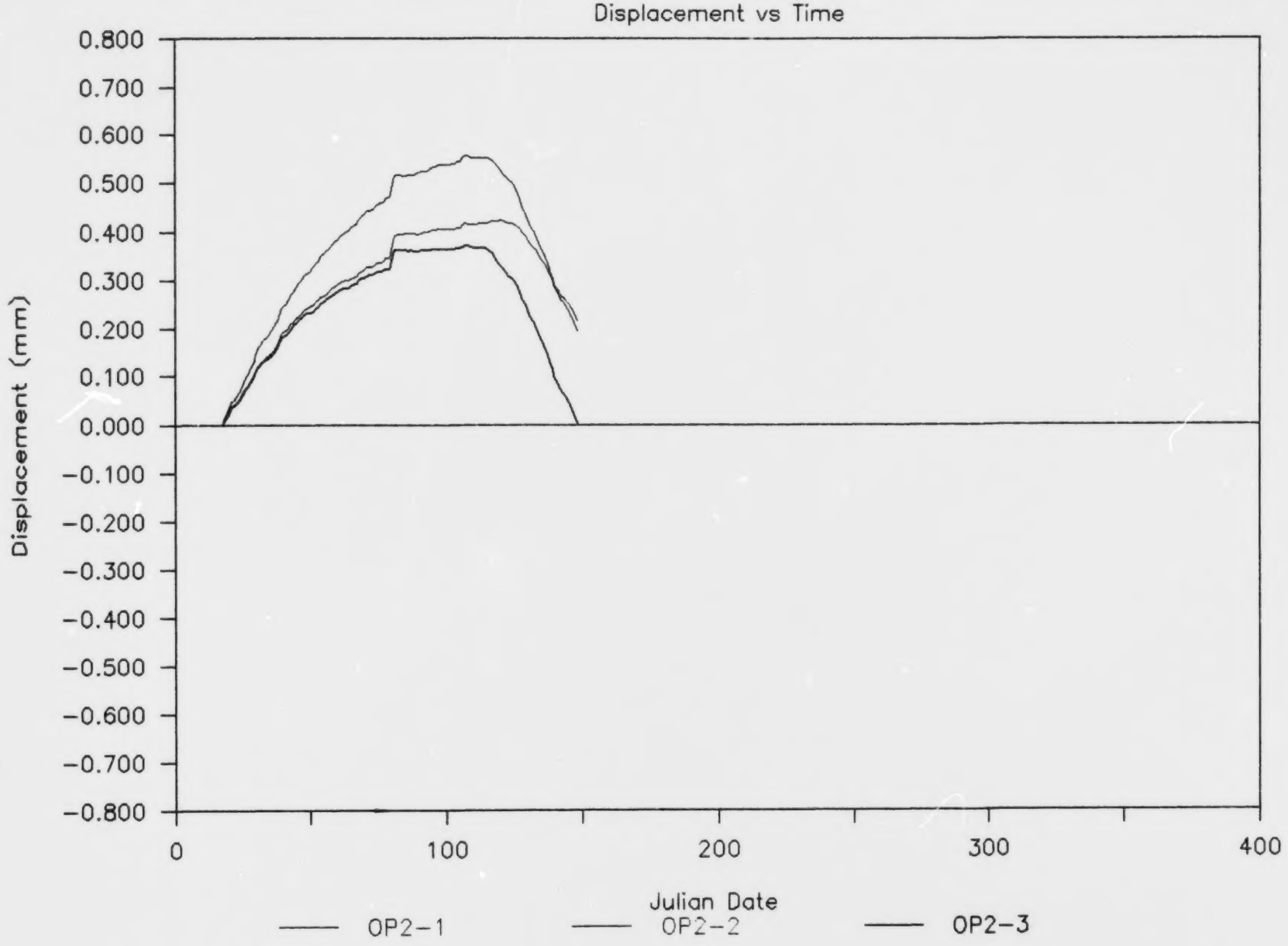
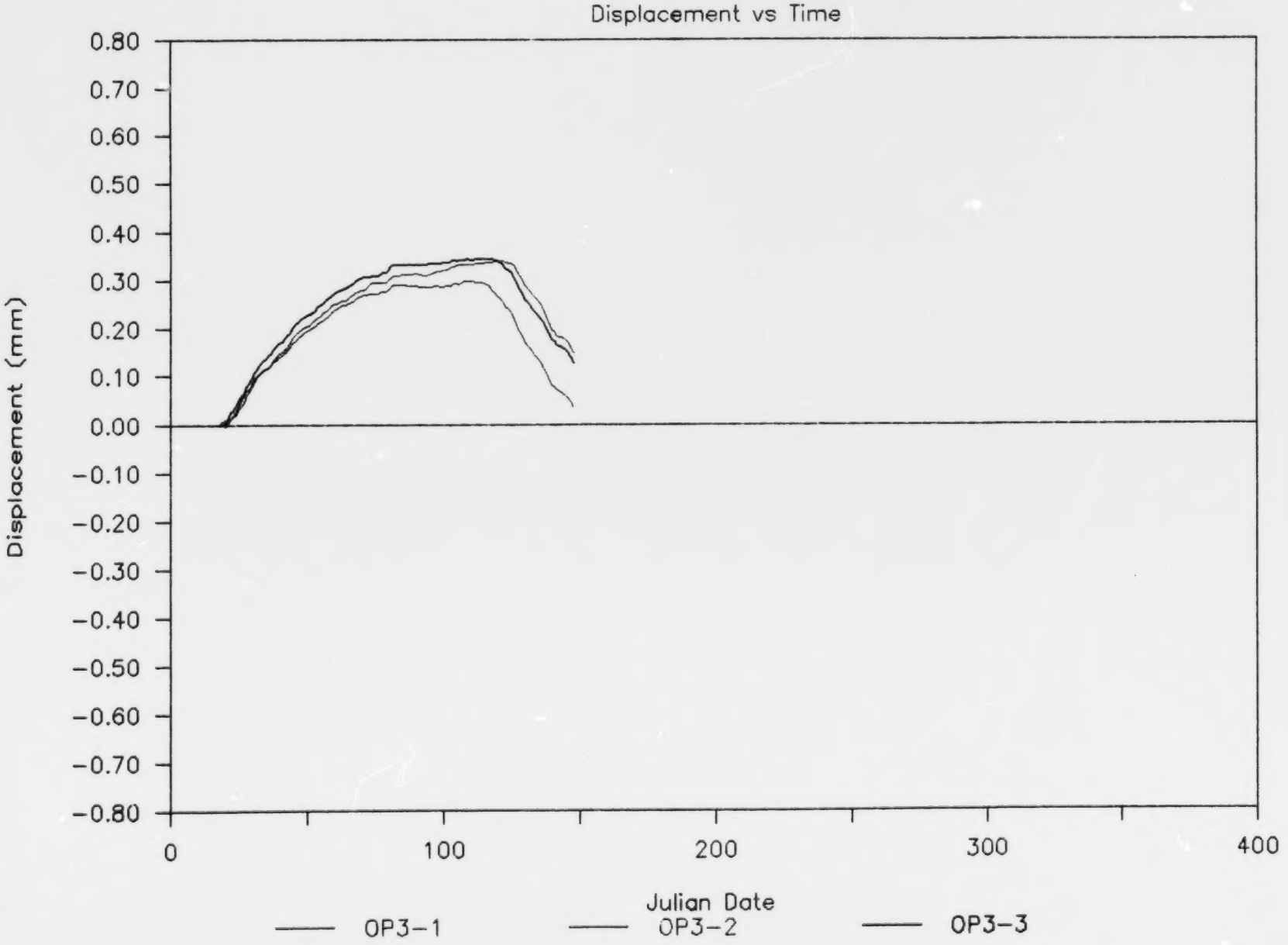


FIGURE 7 - Installed Rebuilt Extensometer Head Showing Brass Supports and LVDT's

OPGS EXTENSOMETER OP2



OPGS EXTENSOMETER OP3



OPGS EXTENSOMETER OP4

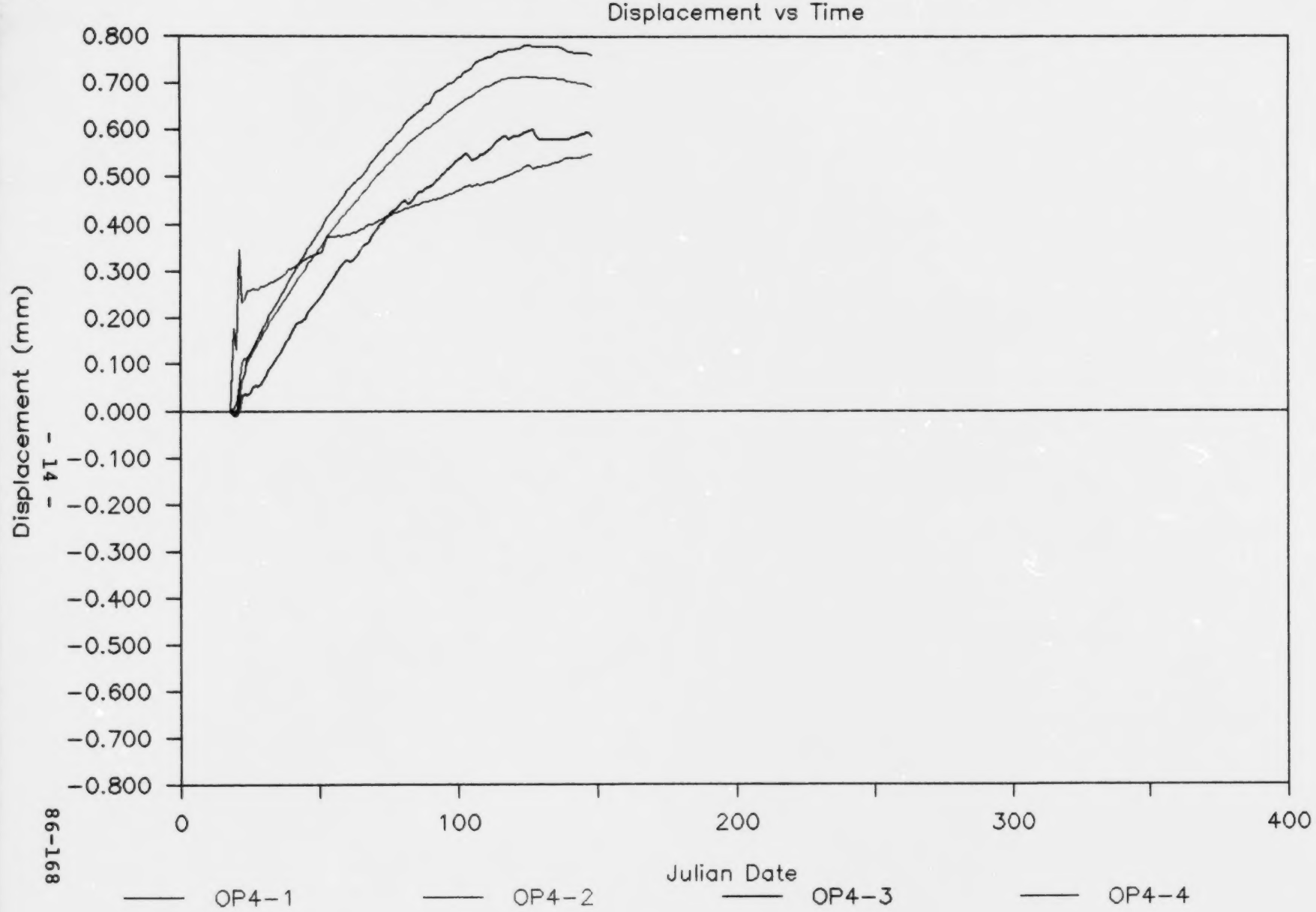


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TABLE 1
VALVE CHAMBER EXTENSOMETERS

VALVE CHAMBER EXTENSOMETER	APPROX. CHAINAGE	ANCHOR POINT	DEPTH (M)	BOREHOLE INCLINATION
OP-2	62+60	OP2-1	34.3	-5 deg
		OP2-2	28.0	-5 deg
		OP2-3	17.1	-5 deg
OP-3	63+61	OP3-1	38.2	-5 deg
		OP3-2	24.7	-5 deg
		OP3-3	35.4	-5 deg
OP-4	65+69	OP4-1	15.2	-5 deg
		OP4-2	30.5	-5 deg
		OP4-3	31.7	-5 deg
		OP4-4	36.6	-5 deg

TABLE 2
JULLIAN DAY CALENDAR

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174	204	235	266	296	327	357
24	24	55	83	114	144	175	205	236	267	297	328	358
25	25	56	84	115	145	176	206	237	268	298	329	359
26	26	57	85	116	146	177	207	238	269	299	330	360
27	27	58	86	117	147	178	208	239	270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362
29	29	60	88	119	149	180	210	241	272	302	333	363
30	30		89	120	150	181	211	242	273	303	334	364
31	31		90		151		212	243		304		365

NOTE: For leap years add 1 starting March 1

TABLE 3

LOTUS INSTRUCTIONS FOR PLOTTING DATA

STEP	CURSOR LOCATION	KEY TO PRESS	COMMENT
****	**********	**********	*******
1	123	ENTER	
2	COPYRIGHT SCREEN	ANY KEY	
3	ABOVE WORKSHEET	/	
4	WORKSHEET	F	FOR "FILE"
5	RETRIEVE	ENTER	
6	OP2	ENTER	
7	ABOVE OP2 WORKSHEET	/	
8	WORKSHEET	F	FOR "FILE"
9	RETRIEVE	I	FOR "IMPORT"
10	TEXT	N	FOR "NUMBERS"
11	OP2	ENTER	
12	ABOVE OP2 WORKSHEET	/	
13	WORKSHEET	G	FOR "GRAPH"
14	TYPE	V	FOR "VIEW"
15	OP2 GRAPH ON SCREEN	/	
16	VIEW	S	FOR "SAVE"
17	OP2	ENTER	
18	CANCEL	R	FOR "REPLACE"
19	SAVE	Q	FOR "QUIT"
20	ABOVE OP2 WORKSHEET	/	
21	WORKSHEET	F	FOR "FILE"
22	RETRIEVE	S	FOR "SAVE"
23	ENTER SAVE FILENAME:OP2	ENTER	
24	CANCEL	R	FOR "REPLACE"
25	ABOVE OP2 WORKSHEET	/	
26	GOTO STEP 4 - REPEAT FOR OP3 AND OP4		
27	WORKSHEET	Q	FOR "QUIT"
28	NO	Y	FOR "YES"
29	123	P	FOR "PRINTGRAPH"
30	SELECT	ENTER	
31	OP2	SPACE BAR	
32	*OP2	CURSOR DOWN	
33	OP3	SPACE BAR	
34	*OP3	CURSOR DOWN	
35	OP4	SPACE BAR	
36	*OP4	ENTER	
37	SELECT	A	FOR "ALIGN"
38	ALIGN	G	FOR "GO"-PLOTS OUT OP2,OP3 AND OP4

APPENDIX A

OPGS VALVE CHAMBER - OP2

Year	Jul Date	OP2-1 Displ (mm)	OP2-1 Chnge (mm)	OP2-2 Displ (mm)	OP2-2 Chnge (mm)	OP2-3 Displ (mm)	OP2-3 Chnge (mm)	Temp Cr7 (C)
86	18	1.444	0	1.743	0	1.68	0	9.49
86	19	1.456	.012	1.764	.021	1.698	.018	9.44
86	20	1.466	.022	1.775	.032	1.701	.021	9.45
86	21	1.482	.038	1.791	.048	1.718	.038	9.45
86	22	1.485	.041	1.794	.051	1.72	.04	9.45
86	23	1.487	.043	1.802	.059	1.726	.046	15.79
86	24	1.494	.05	1.811	.068	1.734	.054	15.76
86	25	1.505	.061	1.825	.082	1.744	.064	15.67
86	26	1.515	.071	1.838	.095	1.753	.073	15.74
86	27	1.523	.079	1.848	.105	1.76	.08	15.73
86	28	1.53	.086	1.858	.115	1.768	.088	15.86
86	29	1.541	.097	1.871	.128	1.779	.099	15.78
86	30	1.553	.109	1.887	.144	1.789	.109	15.39
86	31	1.564	.12	1.902	.159	1.799	.119	15.28
86	32	1.571	.127	1.91	.167	1.806	.126	15.19
86	33	1.577	.133	1.918	.175	1.811	.131	15.11
86	34	1.582	.138	1.925	.182	1.815	.135	15.14
86	35	1.587	.143	1.931	.188	1.819	.139	15.06
86	36	1.592	.148	1.939	.196	1.824	.144	15.04
86	37	1.599	.155	1.949	.206	1.83	.15	15.14
86	38	1.609	.165	1.959	.216	1.839	.159	15.21
86	39	1.624	.18	1.977	.234	1.854	.174	15.24
86	40	1.634	.19	1.986	.243	1.861	.181	14.94
86	41	1.638	.194	1.993	.25	1.865	.185	15.04
86	42	1.644	.2	2.001	.258	1.87	.19	14.97
86	43	1.652	.208	2.013	.27	1.878	.198	14.94
86	44	1.658	.214	2.02	.277	1.886	.206	14.94
86	45	1.663	.219	2.029	.286	1.892	.212	14.97
86	46	1.669	.225	2.038	.295	1.898	.218	14.94
86	47	1.676	.232	2.045	.302	1.903	.223	14.99
86	48	1.683	.239	2.053	.31	1.909	.229	14.87
86	49	1.686	.242	2.057	.314	1.911	.231	14.8
86	50	1.689	.245	2.062	.319	1.912	.232	14.74
86	51	1.693	.249	2.069	.326	1.915	.235	14.76
86	52	1.699	.255	2.077	.334	1.921	.241	14.83
86	53	1.703	.259	2.083	.34	1.925	.245	14.9
86	54	1.708	.264	2.091	.348	1.931	.251	15.01
86	55	1.711	.267	2.098	.355	1.936	.256	14.96
86	56	1.714	.27	2.103	.36	1.94	.26	14.98
86	57	1.72	.276	2.108	.365	1.944	.264	14.99
86	58	1.726	.282	2.115	.372	1.948	.268	14.8
86	59	1.73	.286	2.121	.378	1.952	.272	14.7
86	60	1.734	.29	2.127	.384	1.956	.276	14.65
86	61	1.738	.294	2.132	.389	1.959	.279	14.66
86	62	1.741	.297	2.138	.395	1.962	.282	14.63
86	63	1.743	.299	2.142	.399	1.963	.283	14.5
86	64	1.744	.3	2.146	.403	1.964	.284	14.54
86	65	1.745	.301	2.151	.408	1.967	.287	14.61
86	66	1.748	.304	2.154	.411	1.969	.289	14.63
86	67	1.751	.307	2.159	.416	1.973	.293	14.73

OPGS VALVE CHAMBER - OP2

Year	Jul Date	OP2-1 Displ (mm)	OP2-1 Chnge (mm)	OP2-2 Displ (mm)	OP2-2 Chnge (mm)	OP2-3 Displ (mm)	OP2-3 Chnge (mm)	Temp Cr7 (C)
86	68	1.757	.313	2.167	.424	1.978	.298	14.46
86	69	1.761	.317	2.175	.432	1.983	.303	14.3

OPGS VALVE CHAMBER - OP3

Year	Jul Date	OP3-1 Displ (mm)	OP3-1 Chnge (mm)	OP3-2 Displ (mm)	OP3-2 Chnge (mm)	OP3-3 Displ (mm)	OP3-3 Chnge (mm)	Temp Cr7 (C)
86	18	1.199	0	1.179	0	1.35	0	9.49
86	19	1.204	.005	1.181	.002	1.353	.003	9.44
86	20	1.201	.002	1.177	-.002	1.359	.009	9.45
86	21	1.208	.009	1.178	-.001	1.36	.01	9.45
86	22	1.211	.012	1.19	.011	1.375	.025	9.45
86	23	1.216	.017	1.197	.018	1.379	.029	15.79
86	24	1.221	.022	1.207	.028	1.389	.039	15.76
86	25	1.231	.032	1.219	.04	1.4	.05	15.67
86	26	1.239	.04	1.229	.05	1.409	.059	15.74
86	27	1.246	.047	1.238	.059	1.416	.066	15.73
86	28	1.258	.059	1.247	.068	1.428	.078	15.86
86	29	1.267	.068	1.254	.075	1.437	.087	15.78
86	30	1.277	.078	1.264	.085	1.448	.098	15.39
86	31	1.289	.09	1.275	.096	1.458	.108	15.28
86	32	1.298	.099	1.281	.102	1.467	.117	15.19
86	33	1.305	.106	1.286	.107	1.475	.125	15.11
86	34	1.31	.111	1.293	.114	1.481	.131	15.14
86	35	1.314	.115	1.296	.117	1.486	.136	15.06
86	36	1.318	.119	1.298	.119	1.493	.143	15.04
86	37	1.323	.124	1.303	.124	1.497	.147	15.14
86	38	1.334	.135	1.311	.132	1.507	.157	15.21
86	39	1.341	.142	1.314	.135	1.515	.165	15.24
86	40	1.345	.146	1.318	.139	1.52	.17	14.94
86	41	1.35	.151	1.322	.143	1.523	.173	15.04
86	42	1.354	.155	1.326	.147	1.529	.179	14.97
86	43	1.36	.161	1.333	.154	1.535	.185	14.94
86	44	1.367	.168	1.339	.16	1.541	.191	14.94
86	45	1.379	.18	1.348	.169	1.552	.202	14.97
86	46	1.386	.187	1.353	.174	1.559	.209	14.94
86	47	1.392	.193	1.359	.18	1.564	.214	14.99
86	48	1.397	.198	1.364	.185	1.569	.219	14.87
86	49	1.401	.202	1.369	.19	1.574	.224	14.8
86	50	1.404	.205	1.373	.194	1.577	.227	14.74
86	51	1.405	.206	1.376	.197	1.579	.229	14.76
86	52	1.413	.214	1.38	.201	1.583	.233	14.83
86	53	1.417	.218	1.383	.204	1.586	.236	14.9
86	54	1.42	.221	1.388	.209	1.593	.243	15.01
86	55	1.425	.226	1.392	.213	1.598	.248	14.96
86	56	1.43	.231	1.396	.217	1.602	.252	14.98
86	57	1.434	.235	1.4	.221	1.607	.257	14.99
86	58	1.439	.24	1.405	.226	1.612	.262	14.8
86	59	1.444	.245	1.41	.231	1.617	.267	14.7
86	60	1.449	.25	1.415	.236	1.622	.272	14.65
86	61	1.451	.252	1.42	.241	1.627	.277	14.66
86	62	1.453	.254	1.423	.244	1.629	.279	14.63
86	63	1.456	.257	1.426	.247	1.631	.281	14.5
86	64	1.457	.258	1.428	.249	1.633	.283	14.54
86	65	1.46	.261	1.43	.251	1.635	.285	14.61
86	66	1.463	.264	1.432	.253	1.638	.288	14.63
86	67	1.468	.269	1.435	.256	1.642	.292	14.73

OPGS VALVE CHAMBER - OP3

Year	Jul Date	OP3-1 Displ (mm)	OP3-1 Chnge (mm)	OP3-2 Displ (mm)	OP3-2 Chnge (mm)	OP3-3 Displ (mm)	OP3-3 Chnge (mm)	Temp Cr7 (C)
86	68	1.473	.274	1.44	.261	1.647	.297	14.46
86	69	1.475	.276	1.443	.264	1.652	.302	14.3

OPGS VALVE CHAMBER - OP4

Year Temp Cr7 (C)	Jul Date	OP4-1 Displ (mm)	OP4-1 Chnge (mm)	OP4-2 Displ (mm)	OP4-2 Chnge (mm)	OP4-3 Displ (mm)	OP4-3 Chnge (mm)	OP4-4 Displ (mm)	OP4-4 Chnge (mm)
86 9.49	18	1.179	0	1.55	0	1.212	0	1.279	0
86 9.44	19	1.185	.006	1.727	.177	1.203	-.009	1.272	-.007
86 9.45	20	1.194	.015	1.682	.132	1.203	-.009	1.279	0
86 9.45	21	1.231	.052	1.897	.347	1.212	0	1.303	.024
86 9.45	22	1.283	.104	1.783	.233	1.244	.032	1.346	.067
86 15.79	23	1.293	.114	1.788	.238	1.25	.038	1.357	.078
86 15.76	24	1.285	.106	1.807	.257	1.247	.035	1.394	.115
86 15.67	25	1.295	.116	1.808	.258	1.252	.04	1.402	.123
86 15.74	26	1.306	.127	1.812	.262	1.262	.05	1.413	.134
86 15.73	27	1.315	.136	1.811	.261	1.267	.055	1.424	.145
86 15.86	28	1.326	.147	1.811	.261	1.264	.052	1.436	.157
86 15.78	29	1.335	.156	1.817	.267	1.269	.057	1.447	.168
86 15.39	30	1.347	.168	1.817	.267	1.279	.067	1.459	.18
86 15.28	31	1.358	.179	1.819	.269	1.292	.08	1.472	.193
86 15.19	32	1.369	.19	1.824	.274	1.302	.09	1.485	.206
86 15.11	33	1.378	.199	1.827	.277	1.312	.1	1.495	.216
86 15.14	34	1.387	.208	1.83	.28	1.322	.11	1.505	.226
86 15.06	35	1.395	.216	1.832	.282	1.33	.118	1.514	.235
86 15.04	36	1.404	.225	1.836	.286	1.338	.126	1.524	.245
86 15.14	37	1.413	.234	1.841	.291	1.349	.137	1.535	.256
86 15.21	38	1.421	.242	1.845	.295	1.359	.147	1.544	.265
86 15.24	39	1.43	.251	1.853	.303	1.368	.156	1.558	.279
86 14.94	40	1.439	.26	1.855	.305	1.379	.167	1.567	.288
86 15.04	41	1.449	.27	1.858	.308	1.39	.178	1.576	.297
86 14.97	42	1.457	.278	1.862	.312	1.401	.189	1.585	.306
86 14.94	43	1.466	.287	1.866	.316	1.402	.19	1.596	.317
86	44	1.475	.296	1.87	.32	1.405	.193	1.605	.326

86	45	1.484	.305	1.875	.325	1.412	.2	1.617	.338
14.97									
86	46	1.494	.315	1.878	.328	1.424	.212	1.627	.348
14.94									
86	47	1.503	.324	1.882	.332	1.431	.219	1.637	.358
14.99									
86	48	1.511	.332	1.884	.334	1.439	.227	1.645	.366
14.87									
86	49	1.519	.34	1.887	.337	1.446	.234	1.655	.376
14.8									
86	50	1.527	.348	1.89	.34	1.454	.242	1.664	.385
14.74									
86	51	1.534	.355	1.892	.342	1.461	.249	1.672	.393
14.76									
86	52	1.544	.365	1.91	.36	1.471	.259	1.684	.405
14.83									
86	53	1.555	.376	1.925	.375	1.48	.268	1.694	.415
14.9									
86	54	1.562	.383	1.925	.375	1.488	.276	1.701	.422
15.01									
86	55	1.569	.39	1.924	.374	1.496	.284	1.708	.429
14.96									
86	56	1.576	.397	1.923	.373	1.504	.292	1.716	.437
14.98									
86	57	1.583	.404	1.926	.376	1.513	.301	1.723	.444
14.99									
86	58	1.592	.413	1.925	.375	1.523	.311	1.733	.454
14.8									
86	59	1.6	.421	1.926	.376	1.532	.32	1.741	.462
14.7									
86	60	1.607	.428	1.928	.378	1.535	.323	1.75	.471
14.65									
86	61	1.614	.435	1.929	.379	1.532	.32	1.757	.478
14.66									
86	62	1.621	.442	1.932	.382	1.536	.324	1.764	.485
14.63									
86	63	1.627	.448	1.934	.384	1.541	.329	1.77	.491
14.5									
86	64	1.633	.454	1.935	.385	1.548	.336	1.776	.497
14.54									
86	65	1.64	.461	1.94	.39	1.557	.345	1.779	.5
14.61									
86	66	1.647	.468	1.941	.391	1.566	.354	1.786	.507
14.63									
86	67	1.654	.475	1.947	.397	1.57	.358	1.793	.514
14.73									

OPGS VALVE CHAMBER - OP4

Year Temp Cr7 (C)	Jul Date	OP4-1 Displ (mm)	OP4-1 Chnge (mm)	OP4-2 Displ (mm)	OP4-2 Chnge (mm)	OP4-3 Displ (mm)	OP4-3 Chnge (mm)	OP4-4 Displ (mm)	OP4-4 Chnge (mm)
86 14.46	68	1.66	.481	1.948	.398	1.575	.363	1.801	.522
86 14.3	69	1.668	.489	1.95	.4	1.585	.373	1.81	.531

APPENDIX B

```
F1=Help  F2=Commands                          Insert is On   Param file is op2.PAR
-------------------------------------------------------------------------------
       Name(s) of input DATA FILES(s): \cr7\opgs.DAT
      Name of OUTPUT FILE to generate: op2.prn
            START reading in opgs.DAT:
             STOP reading in opgs.DAT:
                   COPY from opgs.DAT:
      SELECT element #(s) in opgs.DAT: 2,3,5,(5-1.444),6,(6-1.743),7,(7-1.68),1
                                       6
                    HEADING for report: OPGS VALVE CHAMBER - OP2
      HEADINGS for opgs.DAT, col. # 1: Year
                            column # 2: Jul\Date
                            column # 3: OP2-1\Displ\(mm)
                            column # 4: OP2-1\Chnge\(mm)
                            column # 5: OP2-2\Displ\(mm)
                            column # 6: OP2-2\Chnge\(mm)
                            column # 7: OP2-3\Displ\(mm)
                            column # 8: OP2-3\Chnge\(mm)
                            column # 9: Temp\Cr7\(C)
```

```
F1=Help  F2=Commands                          Insert is On   Param file is op3.PAR
-------------------------------------------------------------------------------
       Name(s) of input DATA FILES(s): \cr7\opgs.DAT
      Name of OUTPUT FILE to generate: op3.prn
            START reading in opgs.DAT:
             STOP reading in opgs.DAT:
                   COPY from opgs.DAT:
      SELECT element #(s) in opgs.DAT: 2,3,8,(8-1.199),9,(9-1.179),10,(10-1.35)
                                       ,16
                    HEADING for report: OPGS VALVE CHAMBER - OP3
      HEADINGS for opgs.DAT, col. # 1: Year
                            column # 2: Jul\Date
                            column # 3: OP3-1\Displ\(mm)
                            column # 4: OP3-1\Chnge\(mm)
                            column # 5: OP3-2\Displ\(mm)
                            column # 6: OP3-2\Chnge\(mm)
                            column # 7: OP3-3\Displ\(mm)
                            column # 8: OP3-3\Chnge\(mm)
                            column # 9: Temp\Cr7\(C)
```

```
F1=Help  F2=Commands                          Insert is On   Param file is op4.PAR
-------------------------------------------------------------------------------
       Name(s) of input DATA FILES(s): \cr7\opgs.DAT
      Name of OUTPUT FILE to generate: op4.prn/6
            START reading in opgs.DAT:
             STOP reading in opgs.DAT:
                  COPY from opgs.DAT:
      SELECT element #(s) in opgs.DAT: 2,3,11,(11-1.179),12,(12-1.55),13,(13-1.
                                       212),14,(14-1.279),16
                    HEADING for report: OPGS VALVE CHAMBER - OP4
      HEADINGS for opgs.DAT, col. # 1: Year
                           column # 2: Jul\Date
                           column # 3: OP4-1\Displ\(mm)
                           column # 4: OP4-1\Chnge\(mm)
                           column # 5: OP4-2\Displ\(mm)
                           column # 6: OP4-2\Chnge\(mm)
                           column # 7: OP4-3\Displ\(mm)
                           column # 8: OP4-3\Chnge\(mm)
                           column # 9: OP4-4\Displ\(mm)
                          column # 10: OP4-4\Chnge\(mm)
                          column # 11: Temp\Cr7\(C)
```

SECTION 4. SPLIT

4.1 OVERVIEW

SPLIT is a general purpose data processing program for data produced by the Campbell Scientific, Inc. CR21, 21X, CR7X, and CR7 dataloggers or by SPLIT itself. SPLIT will work on files formatted in Printable ASCII, Comma Delineated ASCII, Final Storage Format or Field Formatted (i.e., as produced by SPLIT). SPLIT runs on the IBM PC and compatible computers.

NOTE: Examples shown in this section may include square brackets. These brackets must be included when shown. (i.e. [])

4.2 GETTING STARTED

The user enters 'SPLIT' on the command line to load and execute the program. The PC must be logged onto the disk and directory containing SPLIT or the appropriate "path" must be specified per the PC-DOS Manual. As soon as SPLIT is loaded, it will request information necessary to find, split, process and store the data specified. Once this information is supplied the program can be executed and saved in a Parameter file for use later.

The following is a simple example of a session with SPLIT. We will assume that the user has a file that contains data from a Campbell Scientific datalogger.

Type 'SPLIT' on the command line after the drive prompt. SPLIT will load and put on the screen the following:

```
F1=Help   F2=Commands                Insert is on  Param file is

 Name(s) of Input DATA FILES(s):
Name of OUTPUT FILE to generate:
              START reading in :
               STOP reading in :
                      COPY from :
       SELECT elements #(s) in :
            HEADING for report :
```

You will enter and/or edit entries to the right of the colons. Type in the name of your file that contains the data-logger data and press return. Now type in a name for an output file, this can be any name you want, (i.e. test.prn) then press return. We will not enter additional parameters at this time.

Press the F2 key and SPLIT will display a command line at the top of the screen which consists of five COMMAND options. They are EDIT, RUN, SAVE, QUIT, and LOAD new parameter file. You can pick any one of these options by pressing the first letter of that COMMAND option or by using the arrow keys to move the cursor to the option you want and then pressing return. Press 'R' for RUN and SPLIT will put your raw data file in columns on your screen and to your Output file.

Section 4.3 describes the parameter entries.

4.3 SPLIT PARAMETER

4.3.1 Name(s) of Input DATA FILE(s):

This file contains the raw data that needs to be split. The user must specify the drive or directory preceding the filename if the file is not on the default drive. SPLIT will immediately search for the file. If the file is not found the program will display an error message. By pressing the F1 key SPLIT will display, at the top of the screen, all files having a .DAT extension name or any files with a different user entered extension name. If an asterik is entered and F1 is pressed SPLIT will display all files on the drive or directory specified before the asterik. An error message is removed when another key is pressed. SPLIT will not save or split a file if an error condition exists.

Multiple files may be split and merged into one output file by entering the input filenames seperated by commas. For example, to split two files named test.dat and test1.dat the user would enter 'TEST.DAT,TEST1.DAT'. SPLIT will ask the same questions for each file on all the remaining parameters. To merge multiple arrays from the same file into one array, the user must enter the input filename separately for each different array. A maximum of eight files may be split at one time.

CAUTION: The PC-DOS operating system allows a user to open up to eight files at one time unless more are specified. Five of the eight are predefined by the operating system, therefore, only three files can be opened by SPLIT. To allow for up to eight files to be opened by SPLIT the user must execute the CONFIG.SYS program on power up. To do this a user must create a file named CONFIG.SYS in the default drive and directory. Contained in CONFIG.SYS file is 'FILES=16'. See the PC-DOS manual (page 4-9) for more information.

Each time it executes SPLIT keeps track of the number of bytes it reads from the input file and saves this information in the Parameter file. Therefore, a user can specify that SPLIT go to the last place in the file that it got to the previous time it

executed. This is specified by appending the input filename with '/LAST' or '/L'. This feature may be used to process only the new data from a file in which new data is being appended periodically (e.g., a data file generated by TELCOM).

By appending the input filename with '/number' SPLIT will "seek" to that position in the file. This option allows the user to save time by starting part way through a large data file. The number specified is the number of characters into the file to start executing the split operations. A Ø indicates the first character in the file. All characters including spaces, carriage returns, and line feeds are counted. The user can specify both where to start and to end the split. For example:

'TEST.DAT/256'

'TEST.DAT/256..1024'

The first example will cause SPLIT to skip 256 characters before beginning the split. The second example will skip 256 characters then split data until character 1024.

CAUTION: There is a possibility that Final Storage Format data can not be detected if the "seek" position is not at the start of an array.

4.3.2 Name of OUTPUT FILE to generate

The file with this name will contain the data split from the raw data file. This file will be created on the default drive or directory unless the user precedes the filename with an alternate drive or directory.

Several output options may be specified to alter the default output to the file. To specify an option the output filename must be appended with a slash and the output option. If no option is specified the output file will be stored under the given filename and displayed to the screen. The following table describes the options.

TABLE 4.3-1 Output Options

OPTION	DESCRIPTION
/O	Omit writing to screen for faster execution.
/P	Print output file. Cannot be used with /R option.
/R	Write a report file to disk with extension name .RPT, to be printed later. Cannot be used with /P option.
/M	Match files. This option will compare two files of the same data and if good data exists in one and not the other (blanks or question marks) then SPLIT will fill the output file with the good data. This might be used to get a more complete record from an error ridden tape (e.g., one recorded at freezing temperatures) by reading the tape twice and running both files through SPLIT.
/S	Suppress form feed and page break to printer or .RPT file.
/G	Outputs only those lines without of range values. See SELECT elements (Section 4.3.6).
/number	Field width of output column (default 8), number can be 6,7,8,9 or Ø. A 'Ø'means output will be comma delineated. **NOTE:** Low resolution Final Storage Data requires a minimum width of 7. High resolution Final Storage Data requires a minimum width of 8.
/[comment]	Comment is stored if data is blank or out of range. The brackets are part of the entry. Whatever the user enters between the brackets will be entered if a blank or question mark is in the data or if data is out of range. This option is useful when the output file is imported into a spreadsheet program, such as Lotus 123, because a blank will foul up the import. For Lotus to work right a blank must be replaced by two quotation marks. The comment cannot exceed the field width.

More than one option can be specified but /R and /P cannot both be specified. Each option must be preceded by the slash.

4.3.3 START reading in

SPLIT allows the user to specify a starting point to begin splitting data. This point can be any element within the array or a combination of elements within an array. For example:

```
                                .
                                .
                                .
01+0115 02+0189 03+1200 04+089.6 05+055.3 06+25.36 07+270.0
01+0115 02+0189 03+1300 04+091.3 05+061.5 06+27.25 07+255.4
01+0115 02+0189 03+1400 04+092.7 05+067.7 06+15.15 07+220.1
01+0115 02+0189 03+1500 04+094.1 05+069.0 06+20.35 07+260.6
                                .
                                .
                                .
```

where 01 = array ID#
02 = julian day
03 = hour
04 = average temperature in deg. F
05 = average soil temperature in deg. F
06 = average wind speed in mph
07 = wind direction in degrees

This array of data contains 7 elements and represents hourly data taken from a datalogger. (This is Printable ASCII Format.) Assume that this data file contains one month of hourly data. We wish to start splitting data at 1500 hours on the first day. Our start value would then be expressed as 3[1500], where 3 is the third element within the array and 1500 is the value of that third element.

The syntax can be expressed as:

el[val]

where el = element within the array
val = the value of that element.

SPLIT allows use of logical "and" and "or" statements when specifying the start value. A logical "and" statement means that all conditions must be true for the statement to be true. The logical "or" statement means that if any of the conditions are true then the statement is true. SPLIT allows the user to enter up to 2 "or" statements. Each "or" condition may have up to 3 "and" statements. A simple logical "and" example follows:

2[189]and3[1200]

Element 2 must equal 189 and element 3 must must equal 1200. It is also possible to specify ranges of vall by putting a ".." between the lower and upper limit. For example:

2[189]and7[200..275]

In this example two conditions must be satisfied to start spliting data. First, the julian day must be 189 and second the wind direction must be between 200 to 275 degrees.

SPLIT has a time "sync" function. This feature is useful when data is missing from files or several files of data need to be merged together. The files are syncronized according to time. This function will sync according to day, hrmn (hour-minute), and/or seconds. The syntax used to identify the time elements is:

el[day]:el[hrmn]:el[seconds]

For example, to identify the julian day, type '2[189]::', for hrmn type ':3[1200]:', and seconds would be expressed as '::4[5]'. A single colon is assumed to be between day and hrmn (e.g., 2[189]: means day, :3[1200] means hours, and 2[189]:3[1200] means day and hour-minute). When the time sync function is used, a time interval must be specified in the COPY parameter (Section 4.3.5). If no time interval is specified in the copy parameter then the time specified in the start condition becomes simply a starting time. The starting time specified must actually be found in the input file before the starting condition is satisfied (e.g., if the input file starts at 11AM and 10AM is entered for the starting time, with no day specified, SPLIT will skip over arrays until it reaches 10 the next day). The time elements can be identified without specifying a starting time (e.g., '2:3'). When no starting time is specified SPLIT assumes the starting time to be Ø and will insert blank lines at the start of the output file. The number of blank lines equals the time between Ø and the time of the first array selected, divided by the interval specified in the COPY parameter.

If multiple input files are given starting times, SPLIT will start the output at the earliest specified starting time. Blanks are inserted for values from other input files until their starting time is reached. If the elements containing the julian day are not specified SPLIT assumes all hrmn starting times to occur on the same day.

Included in the time "sync" function is the ability to tell SPLIT to start relative to the current PC TIME (computer time). This is done by entering a negative unit of time (ie. days, minutes or seconds) from the PC time. This value would then become the start condition for SPLIT.

For example:

':3[-60]'

'2[-3]:3[-120]:'

'2[-0]:'

In the first example the start condition would be the PC time minus 60 minutes. The second example would be the PC time minus 3 days and 120 minutes. Note that the offset to hrmn is specified in minutes only. The third example would be the current day. The actual time SPLIT looks for is the first even multiple of the interval (entered in the COPY parameter) following the PC time minus the offset.

If "start reading in" is left blank, SPLIT will start spliting data at the beginning of the data file.

4.3.4 STOP reading in

The STOP condition allows the user to specify when to stop splitting data based upon a stop value or the END OF FILE (EOF). This feature allows the user to get segments of data out of a large data file. For instance if our data file contained one month of data and we wanted just one day then the Start and Stop values allow the user to get just that days data. When a Stop value is given SPLIT will search for the array containing the Stop value and will <u>not</u> include that array in the split. If the Stop value is not found then SPLIT will display a message that EOF was not found. The user can press ESC (escape) to end or give another filename where the data is continued. This feature is useful when data is contained on several diskettes.

If this parameter is left blank then SPLIT will execute until the EOF.

The STOP value is expressed with the same syntax as the START value.

4.3.5 COPY from

Syntax for the COPY condition is the same as for the START and STOP values mentioned above.

The COPY condition allows the user to specify what to copy to the new data file once the start condition has been satisfied. This means that the COPY condition can be the same as the START value or totally different. For instance, if we wanted only those hours of data when the temperature was above 90 deg. F on day 189. Then we could start with day 189, but only copy those hours when the temperature was between 90 to 150. Assuming that

the start condition had already been entered the COPY condition would be '4[90..150]'.

To use the time "sync" function, time element(s) must be specified in the START parameter (Section 4.3.3). The user specifies a time interval in the COPY condition. For instance, if the original data had 15 minute outputs and you only want hourly outputs, then an interval of 60 minutes must be specified following the element number. This would be entered as (assuming hrmn is element number 3) '3[60]'. Because the START parameter indicates which elements are time, SPLIT automatically looks for the interval if a time element appears in the COPY parameter. The "60" is a time interval i.e. days, minutes, or seconds, not the value of the element. This interval is the unit of time to SYNC each file to. The interval can be given tolerance limits by following the interval with a comma and the tolerance (e.g., '3[60,2]', where 3 is the hrmn element, makes the time interval 60 ±2 minutes). If data does not exist in one of the files at the time specified, then a blank will be put into the output file. Unless you specify differently in the OUTPUT FILE parameter with the [comment] option. (See Table 4.3-2)

If the COPY condition is left blank then SPLIT will copy all arrays between the START and STOP values.

4.3.6 SELECT element #(s) in

This parameter allows the user to specify which elements from the original array or what processed values to include in the output file. The user has the option of just entering the element number(s) (e.g. 2,3,4,5,6,7 or a range for a processed value) or a group of element numbers (eg. 2..7).

SPLIT allows the user to do processing on the data being split. The following is a list of operators, math functions and time series functions supported by SPLIT.

OPERATORS

+ = add
- = subtract
* = multiply
/ = divide
^ = raise to power of

MATH FUNCTIONS

Abs(x)	= Absolute value of x
Arctan(x)	= Arc tangent of x (in degrees)
Cos(x)	= Cosine of x (in degrees)
Exp(x)	= Exponential (e^x)
Frac(x)	= Fractional portion of x
Int(x)	= Integer portion of x
Ln(x)	= Natural log of x
Sin(x)	= Sine of x (in degrees)
SpaAvg(x..y)	= spatial average on elements x through y
SpaMax(x..y)	= spatial max on elements x through y
SpaMin(x..y)	= spatial min on elements x through y
Sqrt(x)	= square root

TIME SERIES FUNCTIONS

Avg(x;n)	= Average
Blanks(x;n)	= Number of blanks in element
Count(x;n)	= Number of data points in element
Max(x;n)	= Maximum
Min(x;n)	= Minimum
Sd(x;n)	= Standard deviation
Smpl(x;n)	= Sample raw value
SmplMax(x;y;n)	= Sample on maximum
SmplMin(x;y;n)	= Sample on minimum
Total(x;n)	= Totalize

SPECIAL FUNCTIONS

"Comment"	= Insert Comment in Output file. (Comment is anything within the quote marks.)
Crlf	= Insert carriage return line feed in Output file.
Line	= Number of lines written to Output file

NOTE: x can be an element or a valid expression.

SYNTAX rules:

- A fixed numeric value must include a decimal point "." or be in scientific notation. There are some exceptions to this which will be noted below.

- Scientific notation has the format "mantissa E power of ten (e.g., 3E5 = 3 x 10^5).

- Element numbers are entered without a decimal point.

- Commas separate output elements (e.g., 2,3,(3+4)/3.2,6).

- Two decimal points are used between a lower and upper limit to indicate a range (e.g., 3..6, refers to the elements 3,4,5, and 6).

- The element or expression which is the argument of a math or time series function must be enclosed in parentheses. A range of elements may be specified and will result in as many outputs as elements (e.g.,-Avg (3..5,7) will output 4 averages). However, if an argument is an expression (i.e., 2.5*3/2) it must be the sole argument of the function.

- Square brackets are used to enclose an allowable range for a value (e.g., 3[3.6..12] indicates that the allowable range for element 3 is from 3.6 to 12). All values within the brackets are numeric (it is not necessary to enter a decimal point). Table 4.3-2 explains how out of range values are treated.

- Semicolons are used in time series functions to separate element numbers from the count which determines the interval. Sample on maximum and sample on minimum require two elements separated by semicolons: The element to check for the max or min followed by the element to sample on the max or min.

The count in a Time Series Function number is optional and does not require a decimal point. EDLOG counts the number of arrays which meet the select condition to determine the interval. If the time "sync" function is specified, the time series functions will remain synced to the starting time even if a complete array is missing from the input data. When elements are missing the time series functions such as average will be computed based on the actual number of elements found, not on the count.

If no count is specified, the output from time series functions will occur only after all arrays within the start and stop parameters have been read (e.g., the average of all values). This summary report may also occur when a count is specified, but only if the input data stops before the final interval is completed. The summary in this case is the result for this last incomplete interval.

The greatest number that can be output is determined by the field width (Table 4.3-1). If the width is 8 or greater the maximum number is 99999; for widths less than 8 the maximum is 9999. Larger numbers will be stored as 99999 or 9999.

Illegal operations (e.g., log of a negative number) will cause SPLIT to store blanks for the output. It is possible to get a run time error (error Ø1) if the floating point math exceeds the limits of the PC.

Several examples of the syntax used for OPERATORS:

3*5	multiply element 3 by element 5
3/5	divide element 3 by element 5
(3..5)/(8..10)	same as 3/8, 4/9, 5/10
3+5	add element 3 to element 5
3-5	subtract element 5 from element 3
(3,9,5)-(8,7,10)	same as 3-8, 9-7, 5-10
3*2.0	multiply element 3 by a fixed number 2

NOTE: Syntax for a fixed number is a "." included in the number.

Several examples of the syntax used for MATH FUNCTIONS:

Sqrt (3)	Output the square root of element 3.
Int (Sqrt(3))	Output the integer portion of the square root of element 3.
Frac(3*2.0)	Output the fractional portion of 2 times element 3.

Several examples of the syntax used for TIME SERIES FUNCTIONS:

Smplmax(3;(4,5);10)	Look for maximum in element 3, on a max sample elements 4 and 5, output max and start new max every 10th array.
Max(3;5)	Get maximum in element 3 and output max every 5th array.
Smpl(3;5)	Sample element 3 every 5th array.
Min((4/100.)+60.)	Determine the minimum of: element 4 divided by 100 plus 60.
Total (5)	Totalize element 5.
Blanks(3)	Outputs number of holes (bad data) in element 3.
Count(3)	Outputs the number of times element 3 has occurred (both good and bad data).

NOTE: Blanks and Count are functions designed to be used for checking the integrity of the data file. A common use for these two functions would be '100.*BLANKS/COUNT'. This equation would

give the percentage of holes (bad data) in the file. If BLANKS and COUNT are the only parameters in the select option then all values are output. Except for the final output of summary values, COUNT and BLANKS are zeroed after they are read, so they cannot be used more than once.

TABLE 4.3-2 Output Options for Out of Range Values

OUTPUT OPTION	ON SCREEN	IN FILE
default	asterik, blinking screen	blanks for bad data
/O	nothing	blanks for bad data
/P	asterik, blinking screen (asterik in printed data)	blanks for bad data
/R	asterik, blinking screen (asterik in .RPT file)	blanks for bad data
/S	Same as /P and /S	
/G	only output lines with bad data	only output lines with bad data
/number	same as default	same as default
/[comment]	same as default	comment

If the SELECT parameter is left blank then SPLIT will include all elements within the array in the split.

4.3.7 HEADINGS for report:

SPLIT allows the user to include a report heading for the split file. Headings will not be in the output file but will be on the screen and in the optional .RPT file. If more than one line is needed for the report then a ' ' denotes a new heading line for the report or column heading. A report heading can have several lines but is limited to a total of 255 characters including backslashs and carriage returns. SPLIT will ask for column headings only if the user enters a report heading name. Time Series Functions have a final output at the end of the report (Section 4.3.6). This summary report may be titled. This is done by putting a semicolon following the report heading, after which you enter the title.

If the user enters 'PCDATE' within the text of the HEADING for the report, SPLIT will insert, in its place, the computer's

current date in the format MM-DD-YY (Month-Day-Year). To get the European format enter 'PCEDATE', this would produce DD-MM-YY.

4.3.8 HEADINGS for column

If a report Heading is specified, then SPLIT will ask for columm headings for each column specified in the SELECT parameter. These headings are limited to a field width one less than the Output field width. A ' ' denotes a new line in the column heading.

4.4 HELP OPTION

In the EDIT mode, the F1 key may be pressed to get help on any parameter. The HELP messages explain the options available and provide examples. The HELP messages appear at the top of the screen. If more information is available than is displayed "<cont>" will show at the bottom of the message. Press any key except ESC to continue the message. If it is the end of the message, the cursor will return to the parameter being edited. The user can get out of the HELP option at any time by pressing the ESC key.

4.5 EDITING COMMANDS

Cursor commands are similar to Wordstar. The commands are summarized below:

CURSOR COMMAD N	KEY(s)
Up	Ctrl E or Up Arrow
Down	Ctrl X or Down Arrow
Left	Ctrl S or Left Arrow
Right	Ctrl D or Right Arrow
Word Left	Ctrl A
Word Right	Ctrl F
Page Up	Ctrl R or PgUp
Page Down	Ctrl C or PgDn
Home	Beginning of parameters
End	End of parameters

Delete Commands

Delete Character at cursor	Ctrl G or Delete Key
Delete Character Left	Backspace Key
Delete Word To Right	Ctrl T
Delete Entry	Ctrl Y

Special Commands

Ctrl KB.....Put entry from cursor to end of entry into buffer. If entry is changed, then buffer is emptied.

Ctrl KC.....Copy contents of buffer at cursor.

Ctrl N.....Enter nulls until end of the line (In effect,starts a new line in the current entry).

F1.....Help for current entry.

F2.....Enter command mode.

{.....Start comment.

}.....End comment.

INS.....Insert off/Insert on.

4.6 COMMAND MENU

To switch to the COMMAND Menu from the EDIT Mode press the F2 key. Select a command by pressing the first letter of that command or use the arrow keys to move the cursor to the command and press return. The user can back out of a command by pressing the ESC key. Five COMMANDs are available. An explanation of each follows.

EDIT

EDIT will put SPLIT into the parameter file for editing (Section 4.3).

RUN

Run will compile the parameters and split the specified data file(s). When execution is complete SPLIT will return to the COMMAND MENU. The ESC (escape) Key aborts execution. Control S halts execution until another key is pressed to resume execution.

SAVE

SAVE will compile the parameters and ask the user for a name for the parameter file. SPLIT gives the filename the extension .PAR unless another extension name is specified. Press return and the current parameter filename will be used.

QUIT

QUIT terminates the SPLIT program. If it is a new parameter file or changes have been made, SPLIT will ask the user if he wants to save the file before terminating.

LOAD new parameter file

LOAD allows the user to specify a new parameter file. If the current file has not been saved, SPLIT asks the user if he wants to save the current file. The Parameter filename must comply with PC-DOS rules for a filename. An extension is optional. If no extension is specified then SPLIT will automatically assign .PAR as the extension. This file contains the parameters for spliting a data file. If the file resides on a drive or directory other than the default drive or directory, the drive and directory path specification (see PC-DOS manual) must precede the filename.

4.7 COMMAND LINE ENTRIES

Existing parameter files can be invoked from the command line. For instance, if a parameter file named "LOGAN" already exists, the user can type on the command line 'SPLIT LOGAN'. This will load SPLIT then find the parameter file LOGAN and put the user in the EDIT mode. For SPLIT to execute and run, an '/R' must be appended to the Parameter filename. SPLIT will allow the user to select different parameters by entering them on the command line after the parameter filename. For example:

'SPLIT LOGAN/R TEST.DAT TEST.PRN'

SPLIT will use the parameters in Logan.Par to split the data from Test.dat into the output file Test.Prn.

A space must be used to separate parameters. SPLIT will use as many entries as exist on the command line, in the same sequence as the Parameter file.

Command line entries are useful for automatic execution of SPLIT in a user generated Batch program.